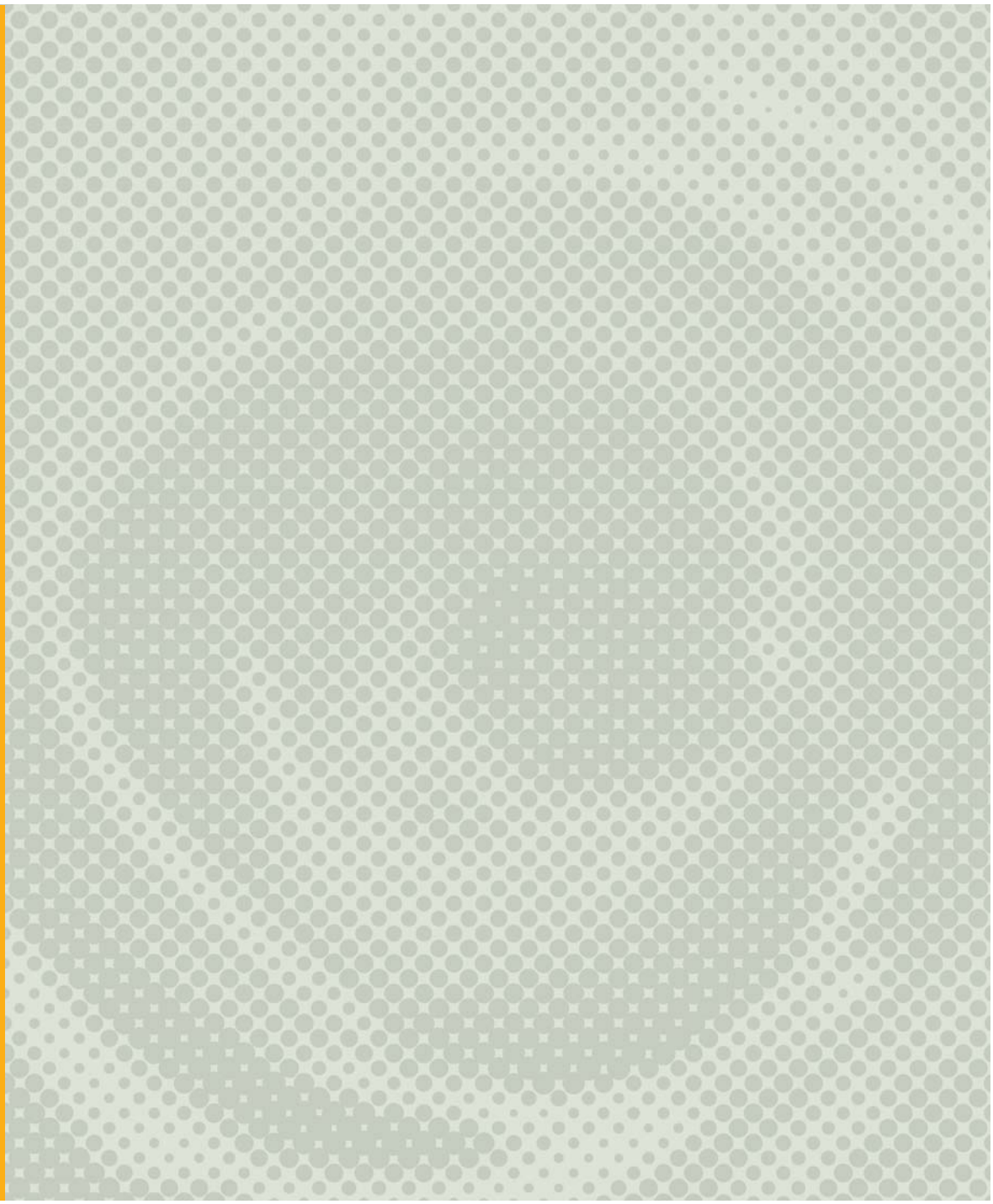
Bears or tears?
A study of people-predator conflicts in the Bolivian Andes

Maria Collett Knagenhjelm

NORWEGIAN UNIVERSITY OF LIFE SCIENCES
DEPARTMENT OF ECOLOGY AND NATURAL RESOURCE MANAGEMENT
MASTER THESIS 60 CREDITS 2007



Preface

This Master thesis is the final result of five years' study of Management of Natural Resources at the Norwegian University of Life Science, Ås. After Jon E. Swenson and Andreas Zedrosser set me in touch with Ximena Velez-Liendo in Bolivia, I took the opportunity to go and study the predator-people interactions in the Andean Mountains. Without Ximena's help, network, and experience the thesis would be quite different than it is today, thank you for the good cooperation!

I would like to give my gratitude to Stein Joar Hegland for helping me out and cheering me up when I got stuck with SPSS, statistics and other obstacles. I am also thankful for having two such experienced and inspiring tutors; Jon E. Swenson and Stein R. Moe at the Institute for Ecology and Natural Resource Management. Thank you for comments and guidelines along the way! My faithful translator and guide around the La Paz District, Erwin Rodriguez Vargas, did an excellent job, thank you for the company and good luck with further studies. Without National Park Director Elias Mamani-Yañes' contact with Ximena, we wouldn't think of starting out in Cotapata. Thank you also Andreas Zedrosser and Bente Knagenhjelm, for very useful comments on the thesis. To Rosa and Hector I thank for giving me an open door in La Paz, and to Ximena's family in Cochabamba for making me feel at home. Park guard Toribio Laura guided us to Chucura, and Angel to Pongo, thank you for the company. And to all the agro-pastoralists in the Bolivian Andes, I want to thank you for your cooperation, may my results hopefully contribute to a better understanding of your situation.

The Statens lånekasse for utdanning gave me a small travel grant; the economic expenses have otherwise been covered by me.

Finally, I give my sincere gratitude to Mum and Paps, for your advice and unconditional support, and for your nourishing dinners when things were difficult. And to Stein Joar, my ever good friend and husband, through this hectic year of our lives.

Content

Abstract

Large predators are currently facing population declines worldwide. High human-induced mortality is a major factor in these declines and livestock depredation is often an underlying reason for conflicts. Many of South America's large predators also are threatened, facing decreased habitats and direct persecution. The endemic spectacled bear (*Tremarctos ornatus*) has been declining in population size along its range in South America, and is a known predator on livestock. By means of a questionnaire (n = 100) I examined people-predator conflicts along the spectacled bear's range in La Paz District in the Bolivian Andes. Livestock predators also included puma (*Puma concolor*), fox (*Pseudalopex culpaeus*) and condor (*Vultur gryphus*). Livestock depredation from 1 January 2000 to July-August 2006 averaged 14.1 ± 2.0 livestock/household, or 2.2 livestock/household/year. Mean depredation rate for households in 2005 was 10.3% of their livestock numbers. Developments of reported depredation were augmenting for all four predators studied from 2000 to 2006, spectacled bear accounting for one third of the total depredation and was thus the most important predator on livestock. Protected areas accommodated more livestock and had higher depredations than non-protected areas, but agro-pastoralist's depredation rate was similar within- and outside protected areas. Depredation rates for cattle increased with distance from the village. People experiencing the highest mean livestock depredation rate most often killed predators as a mitigating method. Hunting was widespread and significantly more spectacled bears were killed outside compared to inside protected areas. People who hunted were not more negative towards large carnivores than those who did not hunt, nor was there any relationship between depredation rates and people's conservation attitudes. Decreasing age and increasing alternative external household income (e.g. mining) affected attitudes towards large carnivore conservation positively. Human-wildlife conflicts in the area might be reduced if herding practices were improved; either with increased attendance of people or by using pastures that are closer to the village. Killing of spectacled bears does not appear to decrease depredation. Attitudes towards illegal hunting and carnivore conservation should be targeted through basic educational programmes to reduce conflict levels between people and predators.

Keywords: Bolivian Andes, livestock depredation, agro-pastoralists, attitudes, illegal hunting, herding practice, spectacled bear, Andean bear, puma, fox, condor, *Tremarctos ornatus, Puma concolor, Pseudalopex culpaeus, Vultur gryphus.*

Abstract in Spanish

A nivel mundial, las poblaciones de grandes depredadores enfrentan una continua reduccion. Como mayor causa es la inducida por humanos la cual responde a conflictos de depredacion del ganado. Una gran mayoria de grandes depredadores en Sud America se encuentran amenazados por la reduccion en su habitat y caceria. El endemico oso de anteojos (*Tremarctos ornatus*) enfrenta reduccion en sus poblaciones a lo largo de su distribucion y es depredador de ganado. A traves de cuestionarios (n = 100) examine los conflictos gente-depredador a lo largo de la distribucion del oso de anteojos en el distrito de La Paz, Bolivia. Depredadores de ganado incluyen puma (*Puma concolor*), zorro (*Pseudalopex culpaeus*) y condor (*Vultur gryphus*). La depredacion de ganado entre 1ro de Enero 2000 a Julio-Agosto 2006 tiene una media 14.1 ± 2.0 ganado/hogar o 2.2 ganado/hogar/ano. La tasa media de depredacion por hogar en 2005 fue de 10.3%. Los reportes en depredacion aumentaron en las cuatro especies de depredadores estudiadas desde 2000-2006. Como mayor depredador esta el oso de anteojos con un tercio del total de las depredaciones. Por lo tanto es considerado el depredador mas importante de ganado. Areas protegidas tambien cobijan ganado y contienen mayor depredaciones que las areas no protegidas, pero la depredacion agro-pastoril fue similar dentro y fuera las areas protegidas. Las tasas de depredacion de ganado incrementaron con la distancia a las comunidades. Comunidades con altas tasas de depredacion de ganado usualmente cazan a los depredadores como un metodo de mitigacion. La caceria de depredadores es amplia, sin embargo mas osos de anteojos son cazados fuera de las areas protegidas. No se encontro diferencia entre la percepcion negativa hacia depredadores por cazadores y no-cazadores, como tampoco se encontro relacion entre tasas de depredacion y la percepcion hacia la conservacion. Comunarios mas jovenes e ingresos economicos alternos (ej. mineria) afectan positivamente las actitutes hacia la conservacion de grandes carnivoros. Conflictos gente-vida silvestre puede ser reducida si las practicas de pastoreo mejoran, ya sea a traves de vigilancia constante o utilizando pastizales mas cerca a las comunidades. La caceria del oso de anteojos no disminuye la perdida de ganado. Actitudes hacia la caceria ilegal y conservacion de carnivoros debe ser enfocada en programas de educacion para reducir los niveles de conflicto entre gente y depredadores.

Palabras clave: Andes Bolivianos, depredacion de ganado, agro-pastoril, actitudes, caceria ilegal, practicas de pastoreo, oso de anteojos, oso Andino, puma, zorro, condor, *Tremarctos ornatus, Puma concolor, Pseudalopex culpaeus, Vultur gryphus.*

Introduction

Ongoing conflicts between people and wildlife exist in many parts of the world, with carnivores often playing a major role. Worldwide, human activities have caused declines in a majority of the worlds' large carnivore species (Fuller 1995; Servheen, Herrero & Peyton 1999), and active persecution appears to be the single most important factor (Woodroffe & Ginsberg 1998). Human-carnivore conflict has been defined as "carnivore-related threats to human life, economic security or recreation" (Treves & Karanth 2003), and there are several reasons for their existence. Conflicts between carnivores and humans tend to occur when human populations and housing expand into formerly pristine areas (Woodroffe 2000), and when management policies have allowed the recovery of long-absent large carnivore populations (Breitenmoser 1998; Saberwal et al. 1994). The large home ranges of many carnivores increase the risk of direct confrontation with humans, in particular in areas dominated by livestock management (Michalski et al. 2006). Other reasons for human-carnivore conflicts may be decreasing wild prey populations or increasing livestock abundance (Bagchi & Mishra 2006), or the combined fear and lack of knowledge among local inhabitants (Røskaft et al. 2003). Woodroffe (2001) suggested that species most involved in conflicts with people also are those most exposed to extinctions. Large carnivores are a particularly vulnerable group, because of their extensive area requirements, their slow reproductive rates and their predatory behaviour, both on wild prey and on livestock (Nowell & Jackson 1996). In addition, recent studies indicate that they face higher extinction risks and are more predisposed to decline than smaller mammals (Cardillo et al. 2005).

The human threat towards carnivores may be driven by several factors. A large proportion of carnivore mortality is caused by people who experience carnivores as threatening (Ogada et al. 2003). However, human attitudes towards wild animals tend to be based on peoples' knowledge and understanding from past and present experience with the particular carnivore species (Kellert et al. 1996). Potentially, local people have a large impact on the nature around them, through hunting, livestock holdings and generally through their presence. Therefore, understanding the attitudes of local people is important to understand a conflict. Carnivore management throughout history has often been adapted to records of human-carnivore interactions (Breitenmoser 1998). People living in, or near, protected areas often view protected-area authorities as responsible and answerable when conflicts involving wildlife arise (Paisley 2001; Wang & Macdonald 2006), and establishments of protected areas

have, in some cases, even lead to increased livestock depredation due to wild carnivores (Mishra 1997; Saberwal et al. 1994; Wang & Macdonald 2006).

Several of South Americas large carnivores are categorized on the World Conservation Union's (IUCN) Red List (IUCN 2006). The spectacled bear (*Tremarctos ornatus*) is an endemic species in South America, and is found in Venezuela, Colombia, Ecuador, Peru and Bolivia. It is listed as globally threatened, because of habitat loss, illegal hunting and unsustainable resource use by local people (Servheen, Herrero & Peyton 1999). Only half of the spectacled bear's original range is left, and population estimates show a dramatic decline (Goldstein 2007), because of human-induced mortality and landscape fragmentation (Kattan et al. 2004). Presently, there are few conservation efforts (Servheen, Herrero & Peyton 1999) and although there has been no systematic long-term documentation of spectacled bear conflicts, bears are often blamed for livestock predation in areas of its distribution (Goldstein et al. 2006). One-third of the spectacled bear's total range is within Bolivian borders (Peyton 1999), yet Bolivia is the country supplying the least information about this species (Rumiz & Salazar 1999).

The aim of my study was to examine the conflict between wild predators and agro-pastoralists in the Bolivian Andes, with a special focus on the endemic spectacled bear. I explored the depredation patterns of wild predators in time and space, and the attitudes and perceptions towards predators among people in both protected and non-protected areas to answer the following questions: 1) Do livestock depredation patterns differ between protected and non-protected areas? 2) How do different herding practices affect livestock depredation rates and does depredation prevention influence livestock loss? 3) Do high livestock depredation rates result in increased hunting activities among agro-pastoralist? 4) Are people's attitudes towards the conservation of large carnivores influenced by the amount of their livestock loss?

Methods

Study area

The data collection was performed in the La Paz District; along the Cordillera Apolobamba and Cordillera Real, mountain ranges in Bolivia (Figure 1). The La Paz District lies between Peru to the west, the Amazonian Basin in the north-east and east, and the southern highlands.

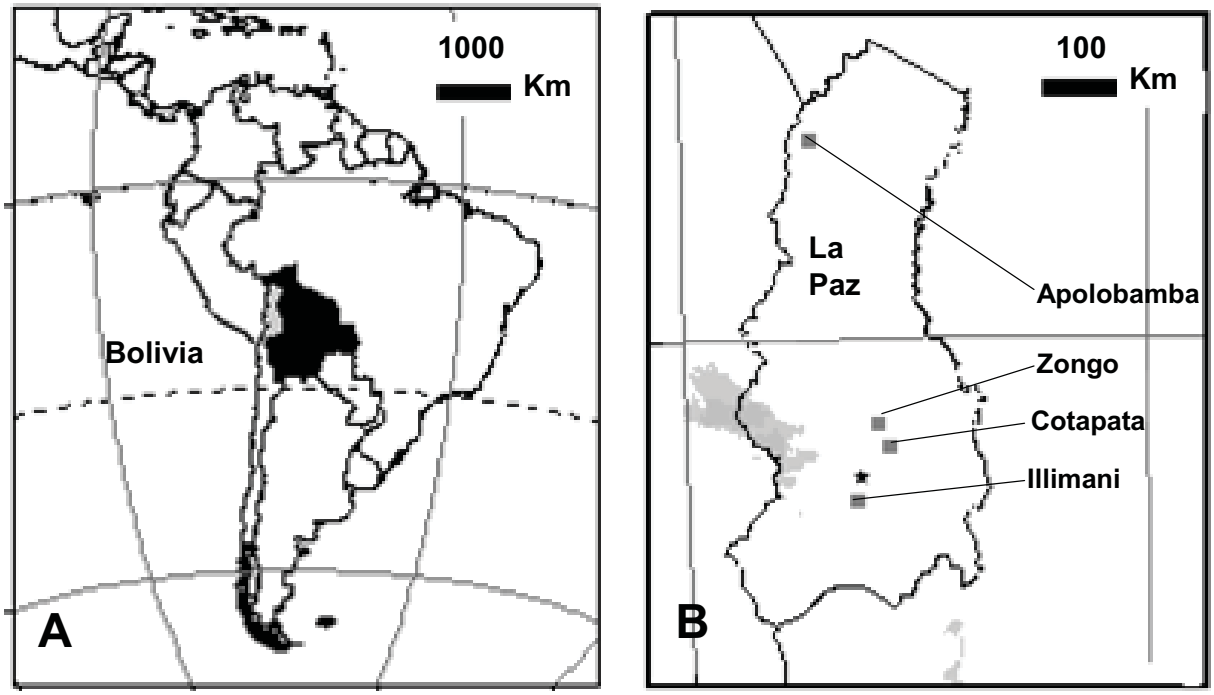


Figure 1, A: The South American continent, with Bolivia in black and La Paz District in light grey. B: The La Paz District, with the four study areas marked with boxes. Bolivia's capital La Paz is marked with a star.

Four areas were investigated, including both protected areas and non-protected areas. The areas were chosen based on unofficial reports of depredation cases and are within the range of the spectacled bear in Bolivia (Velez-Liendo, X., unpublished data). Cotapata is a 60,000 ha protected area established in 1993, including both a National Park and a Natural Area of Integrated Management (NAIM). I collected data in the NAIM part of Cotapata. The NAIM comprises 60% of the area (ParksWatch 2004a). Apolobamba is also a NAIM, established in 1972, and consists of 483,743 ha (ParksWatch 2004b). A NAIM is an area where the conservation of biological diversity is compatible with sustainable development of local human populations (Fernandez 2004). Different protected areas in Bolivia, like the

NAIMs of Apolobamba and Cotapata, support some kinds of land use by the population living inside the area's boundaries. I also investigated two non-protected areas, Illimani and Zongo Valley. Nine villages were surveyed within these four areas (Table 1).

Table 1: The distribution of the interviewed agro-pastoralists within the examined areas.

Area	Status	Village	GPS position	Altitude (m)	Families per village (with livestock)
Cotapata	NAIM*	Chucura	19 K 0605131	3651	80 (35)
		Samaña Pampa	19 K 0601480	4001	6 (6)
		Pongo	19 K 0610721		
Apolobamba	NAIM*	Pelechuco	19 L 0492395	3593	200 (35)
		Aguas Blancas	19 L 0488153	3804	80 (12)
Illimani	Not protected	Lambate	19 K 0638236	3404	70 (60)
Zongo	Not protected	Cahua	19 K 0604276	1514	18 (5)
		Cañaviri	19 K 0592353	3417	15 (10)
		Botijlaca	19 K 0591833	3583	35 (15)

* Natural Area of Integrated Management

Except for the small village of Cahua, all surveyed villages were located more than 3000 meters above sea level, where the neotropical *páramo* is the dominating ecosystem. The high altitude *páramo* is a grassland and shrubland ecosystem, consisting of tussock grasses, dwarf shrubs, conspicuous ground rosettes like *Puya* spp. and *Espeletia* spp. Woody tree species like *Polylepis* spp. and *Gynoxys* spp. occur locally in sheltered patches (Navarro & Maldonado 2005). The Andean Mountain ranges at this altitude have seasonal rains most intensively between October and March, whereas April to October is drier and has lower temperatures.

The common languages spoken in the rural parts of La Paz are Aymara and Quechua, although many, mostly young people, also speak Spanish. In Bolivia the literacy level is 86.7%, and men have a higher level (93.1%) than women (80.7%) (CIA 2007). The educational level of the interviewed population in the rural areas was low however; most of the older people in the study area were illiterate. People in the areas were mostly agro-pastoralists, with self-sustained low-income households. The average household has a few livestock, hereby defined as cattle (*Bos taurus*), llamas (*Lama glama*), sheep (*Ovis aries*), horses (*Equus caballus*), mules (*Equus caballus x asinus*), donkeys (*Equus asinus*) and alpacas (*Vicugna pacos*). The large majority of households grow crops like potato (*Solanum tuberosum*), oca (*Oxalis tuberose*), and maize (*Zea mays*) at lower altitudes. Other sources of income include working as sherpas or guides, as miners, or small-scale commercial business. Several households in the Zongo area had members with part or full-time employment in the valley's electrical plant. Livestock, and especially larger animals, like cattle and horses, are

often the most important financial reserve of the household. The combination of livestock grazing and crop production is the most common livelihood strategy in the rural areas, both inside and outside the areas of integrated management.

Cattle, horses, llamas, donkeys, and mules are often left grazing unattended in the páramo for one to three weeks. Sheep are commonly guarded by herders with dogs during the day, and enclosed in corrals in the village/on the farm at night. The total number of livestock owned by the respondents was 3,667 animals. Sheep and cattle comprised the large majority, with 39.5% and 28.2%, respectively. Llamas were 19.1%, alpaca 6.2%, horses 5.3%, mules 1.5% and donkeys 0.3% of the total livestock in the four surveyed areas.

Common wild herbivore species include Andean deer (*Hippocamelus antisensis*), white-tailed deer (*Odocoileus virginianus*), and mountain viscacha (*Lagidum peruanum*) (Emmons & Feer 1999). The rare and threatened vicuña (*Vicugna vicugna*) is found in Apolobamba NAIM (ParksWatch 2004b). Common carnivores include puma (*Puma concolor*), Andean fox (*Pseudalopex culpaeus*) and spectacled bear; the jaguar (*Panthera onca*) lives in lower altitudes (Emmons & Feer 1999). Smaller carnivores like Andean cat (*Oreailurus jacobita*) and ocelot (*Leopardus pardalis*) also occur in the páramo ecosystem, but are more common in lower attitudes (Emmons & Feer 1999). The condor (*Vultur gryphus*) is a common vulture in the study area. IUCN (2006) listed the spectacled bear as vulnerable and the jaguar, puma and condor as near threatened.

In Bolivia hunting, transport and trade of endangered species, including the spectacled bear, was banned in 1979 (Servheen, Herrero & Peyton 1999). Seven years later the ban extended to include all wildlife in Bolivia for three years, but already the year after, in 1987, the ban was extended indefinitely (Servheen, Herrero & Peyton 1999).

Data collection

I collected data during July and August 2006 by interviewing 104 livestock owners with the use of a questionnaire (Appendix 1). I used a Spanish-speaking translator during data collection because of my lack of knowledge of indigenous languages. In the villages a local guide identified households owning livestock. As many of these households as possible were interviewed, and never less than 40% of all the livestock owners in a village. The number of households interviewed in Cotapata was 33, in Apolobamba 24, in Illimani 24 and in Zongo 19. I excluded from analysis respondents with pigs (n = 2), one respondent who clearly had other intentions than reporting real numbers (n = 1) and one who did not wish to report the

number of livestock owned (n = 1). Four persons did not wish to participate. Totally this resulted in 100 households for data analysis.

Respondents (the heads of the house or their spouses) were asked if they had livestock and were interested in answering some questions. Whenever possible, I revisited a household if nobody was present at the first visit. Only people with either cattle, llamas, sheep, horses, mules, donkeys or alpacas were used in this study.

The questionnaire included both open-ended and closed questions. I interviewed people directly, but several questions were indirect, as for hunting issues. Because hunting is illegal, the respondents were asked whether hunting was normal in the village or if they knew of people conducting this activity. Indirect questions reduce bias on issues subject to social influence (Fisher 1993). Respondents were asked questions relating to household demographics, occupations, number of livestock and herding practices. To ensure that we were talking about the same animal they were asked whether they had encountered any predators, and if they could describe the spectacled bear and puma. To document the actual conflict, pastoralists were asked in detail about depredation incidents between January 2000 and the time of the interview (July - August 2006), and how they recognised predator attacks. To document the perceived conflict, I asked what they regarded as threats towards the village. People were also asked whether hunting was normal or not in the village, with information of what animals were hunted and for what reasons hunting was conducted. Finally all respondents were asked if they were willing to collaborate in the conservation on large carnivores, and why or why not. There were no official records of depredation in these areas prior this study.

Data analysis

People's descriptions of spectacled bears and pumas, and how they attack livestock, have been described qualitatively. I otherwise organized most answers from the open-ended questions into groups; binary groups for Chi-square analysis and multiple groups for one-way ANOVA.

As livestock numbers were collected in 2006, the depredation rate was calculated by dividing depredation numbers in 2005 by the number of livestock each farmer had in 2006, assuming that livestock numbers had not changed much from 2005 to July - August 2006. To calculate differences in predation inside and outside protected areas, I used the Student's t-test. I collected systematically, but qualitatively, other causes of livestock mortality. I used a

linear regression analysis to analyze the relationships between distances from the village to the location of grazing livestock. All distances were expressed in hours of human walking from the village or farm. If the respondents gave a time interval, i.e. 1 - 3 hours, I used the median, i.e. 2 hours. I tested if the residuals were normally distributed with a one-sample Kolmogorov-Smirnov test, and if $P < 0.05$ I log-transformed the data ($\log x + 1$).

To investigate whether methods of depredation prevention influenced depredation rates, I organized the open responses into six groups, and used a one-way ANOVA to test the homogeneity of variances. The dependent variable was the 2005 depredation rate; the independent variable was the six ways of depredation prevention. The first group stated it did nothing to prevent depredation or did nothing after depredation occurred. The second group said it scared the predators away; by burning mountain sides as the predators apparently dislike fire and therefore keep away from newly burned areas, and those who scared off predators with dynamite or by shots in the air from firearms. The third group consists of those who killed predators. Group number four moved their animals closer to the village after an attack, or if they knew there were predators in the area. The fifth group stated they visited the livestock more often, stayed closer and took better care of them. The sixth group of respondents moved their animals to other locations. For the post hoc testing I used a Dunnett's t-test, with the 'doing nothing' group as control and then compared the other groups against that. If a respondent used several different methods, I chose the first mentioned alternative for analysis.

Respondents had a range of different explanations for the widespread hunting activity. I used Pearson's chi-square analysis, and organized people's explanations into five categories; hunting for livestock protection, for food/materials, to trade in the market, for cultural purposes, and other reasons. Some people mentioned more than one category. To analyse the significance of age on attitudes towards conservation and hunting, I used a forward binary logistic regression, with age as the dependent factor and attitude towards carnivore conservation as the independent factor.

When asking people about their attitudes concerning large carnivore conservation, I used Pearson's chi-square test and grouped the qualitative data into two categories; where 1 was positive respondents 'yes, because the animals belong to the Bolivian fauna' and 0 was negative respondents 'no, they are dangerous and should be killed'. There were many people stating 'yes, I am positive, but *only* if they don't eat my animals'. These last responses I analysed in two different ways to see if they differed. Because they said *yes*, I first included them in the 1-group, in the other I categorized them into the 0-group, as they were only

conditionally positive. All data analysis was performed using SPSS 13.0 for Windows Integrated Student Version and SPSS 12.0.1 for Windows regarding binary logistic regressions.

Results

Predator identification

To ensure reliability of depredation data, I asked respondents in detail about appearance and identification of spectacled bear and puma. The level of knowledge among people was generally high. Four respondents had reportedly had direct visual observations of spectacled bears attacking and eating cattle and llamas. Half reported to have had visual observations of puma. People reported that spectacled bears attack during daytime, mostly at day break and at dawn, while bears sleep at midday and at night. Several reported that male bears attack more frequently than female bears. Pumas were said to attack by night, while fox attack both day and night.

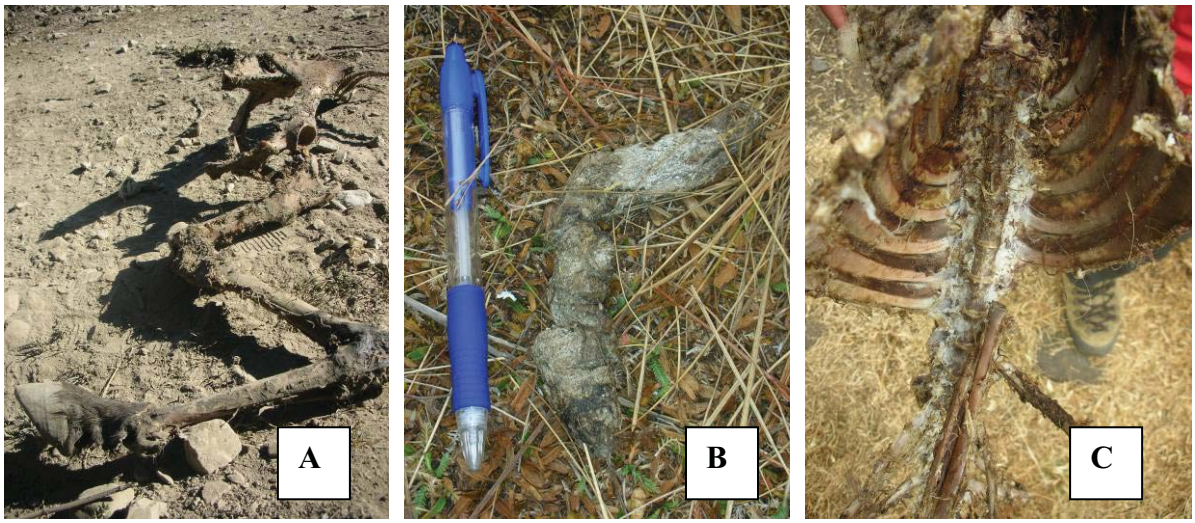


Figure 2: A) Carcass of a cow near the village of Pelechuco, reportedly attacked by the spectacled bear. B) Fox excrements with sheep wool near the village of Chucura. C) Sheep carcass, reportedly attacked by a fox near the village of Chucura. Photos by Maria C. Knagenhjelm.

Livestock depredation

Totally 88% of the agro-pastoralists were affected by livestock depredation between January 2000 and July-August 2006, and depredation affected 68% of the households in 2005. Totally, 1406 livestock were reported killed by wildlife between January 2000 and July-August 2006 from the four different study areas (Table 2). The mean loss of livestock from every household during the 6.5 years was 14.1 ± 2.0 animals, or 2.2 per year.

Table 2: Reported depredation from livestock owners by spectacled bear, puma, fox, and condor between 2000 and July/August 2006 in the Bolivian Andes.

	Cotapata				Apolobamba				Illimani				Zongo				
	Bear	Puma	Fox	Condor	Bear	Puma	Fox	Condor	Bear	Puma	Fox	Condor	Bear	Puma	Fox	Condor	TOTAL
Cattle	104	12	0	7	247	8	0	91	63	0	0	68	59	0	0	25	684
Llama	38	122	0	0	0	67	39	35	0	0	0	0	0	4	35	0	340
Sheep	0	0	196	0	0	0	5	0	0	0	131	0	0	0	10	0	342
Horse	4	0	0	0	6	0	0	0	0	0	0	1	0	0	0	0	11
Mule	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Donkey	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2
Alpaca	0	0	0	0	0	7	19	0	0	0	0	0	0	0	0	0	26
TOTAL	146	135	196	7	255	82	63	126	63	0	131	69	59	4	45	25	1406

The mean depredation rate (i.e. livestock depredation per owner in relation to his herd size) was 0.10 ± 0.02 in Apolobamba, Cotapata 0.12 ± 0.02, Illimani 0.12 ± 0.02 and Zongo 0.07 ± 0.02 per respondent in 2005. In the study area as a whole, the agro-pastoralists lost an average of 10.33 ± 0.01 of their livestock in 2005.

There was a clear peak in reported mean livestock depredation by spectacled bear, puma, fox and condor in 2005 (Figure 3). The spectacled bear was the most important livestock predator during the time period, but for 2005, more livestock were killed by fox. It is important to note that data from 2006 only represents the first 7-8 months of the year, and thus are not suited for comparison with other years.

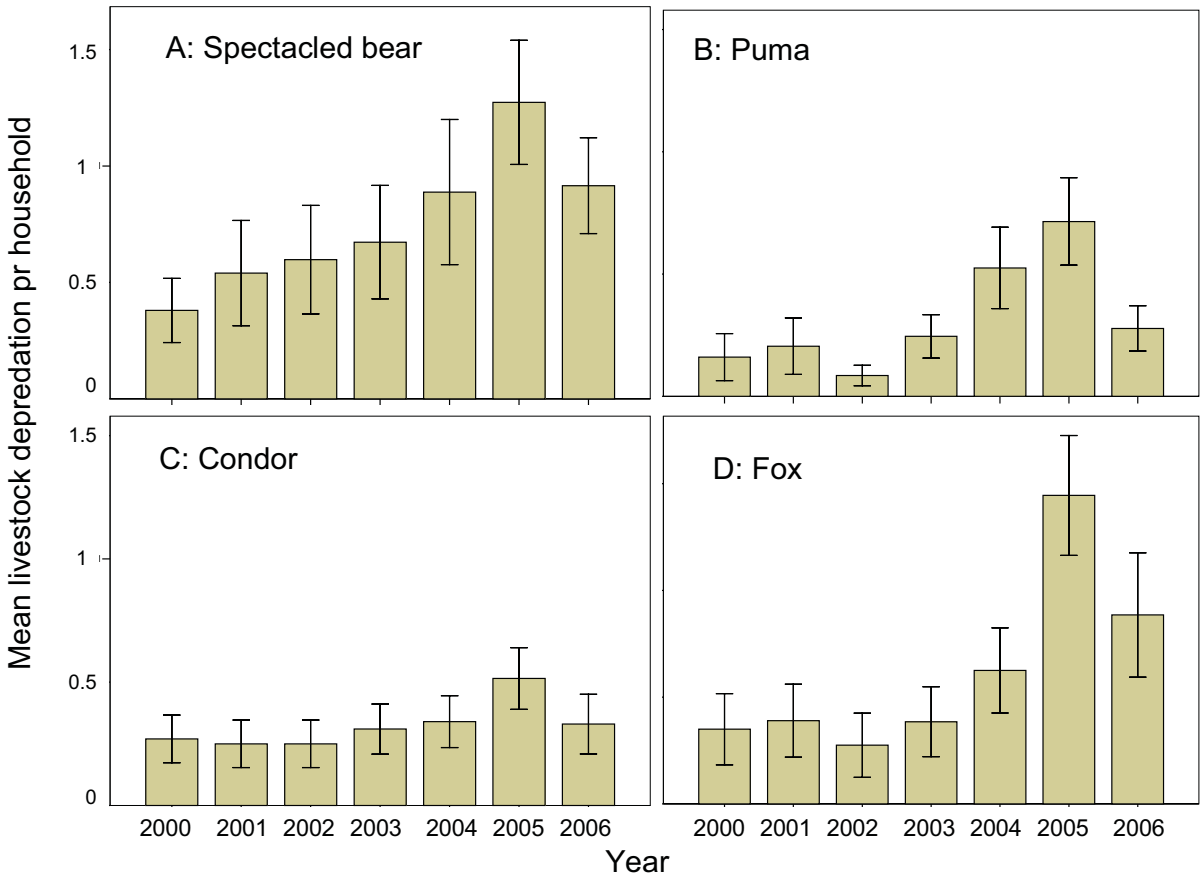


Figure 3: Reported mean ± SE number of livestock depredated per household from 2000 to 2006 by A) spectacled bear, B) puma, C) condor, and D) fox. Note that data from 2006 only count from January to July-August.

Households with livestock in protected areas held significantly more livestock than those in non-protected areas (two-tailed t-test: $t = 4.09$, $df = 94$, $P < 0.001$). The average number of livestock per household in the study area as a whole was 36.7 ± 3.3 animals; whereas protected areas had in average 47.1 ± 4.8 animals and non-protected areas had 22.9 ± 3.4 animals. Cattle, llamas and donkeys were all significantly more numerous in protected areas (all $t > 2.19$, $P < 0.03$).

The total numbers of livestock depredated was significantly higher in protected areas than in non-protected areas ($t = 2.13$, $df = 98$, $P = 0.04$), and the puma accounted significantly for this ($t = 5.78$, $df = 57$, $P < 0.001$). Depredation rates inside protected areas averaged 0.11 ± 0.1, and outside 0.10 ± 0.2, thus did the area's status not determine any difference in depredation rate ($t = 0.45$, $df = 98$, $P = 0.66$).

Effects of herding practice on depredation

Donkeys grazed furthest away from households (n = 4) with a mean walking distance of 3.25 ± 1.33 hours. Households with cattle (n = 82) averaged 2.94 ± 0.17 hours, horses (n = 42) 2.04 ± 0.21 hours, llamas (n = 39) 1.95 ± 0.20 hours, sheep (n = 42) 1.71 ± 0.25 hours, mules (n = 13) 1.67 ± 0.22 hours, and alpacas (n = 6) 1.42 ± 0.54 hours away from the village. People mostly used small roads or landscape tracks, or a combination of these, to reach their animals.

I found a strong positive relationship between walking distance to livestock and depredation rate for cattle (simple linear regression: n = 82, t = 4.00, R^2 = 0.17, P < 0.001), but no significant relationship for llamas (n = 39, t = -1.31, R^2 = 0.05, P = 0.2) or sheep (n = 42, t = -0.52, R^2 = 0.01, P = 0.60). For cattle (Figure 4), the further the herder walked to se them, the greater risk of attacks from predators. Horse, donkey, mule and alpaca had too few cases of depredation to ensure sufficient variation in the response factor to apply regression analysis.

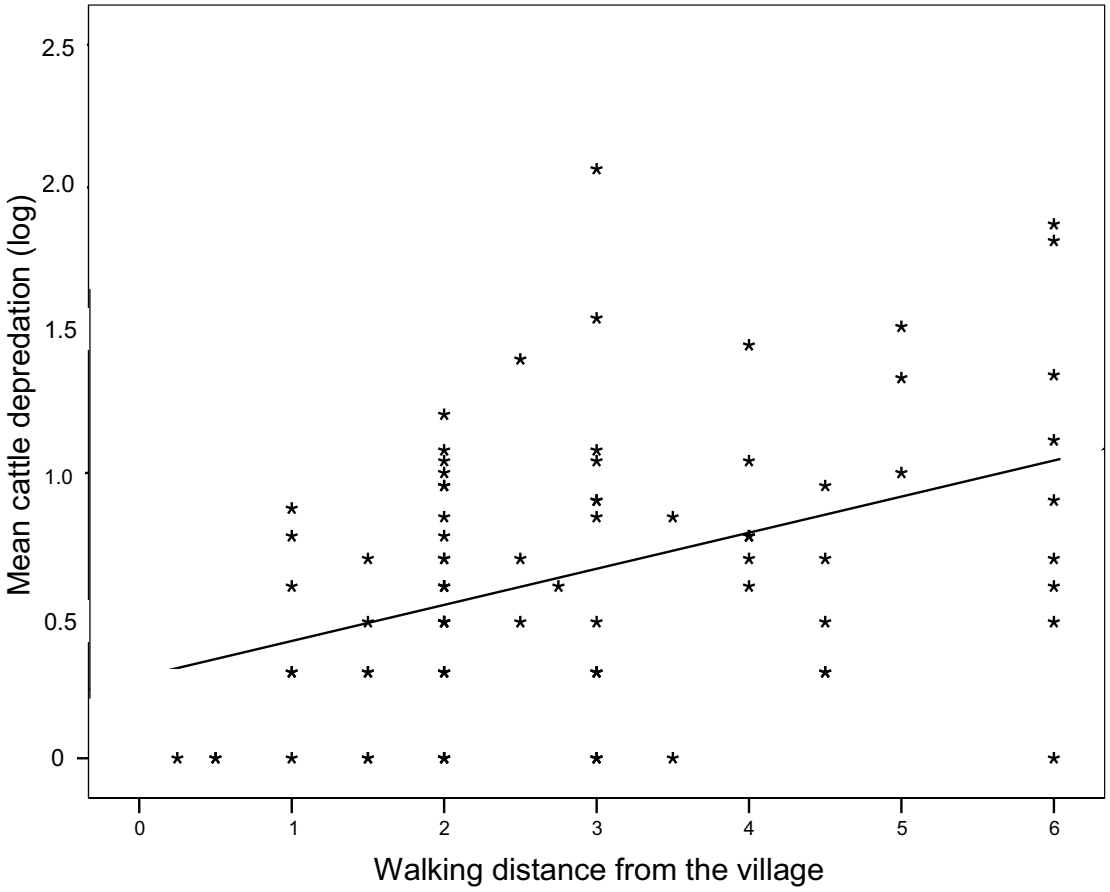


Figure 4: Relationship between mean cattle depredation rate and walking distance in hours from the villages along the study area in the Bolivian Andes. Six hours refers to six hours and more.

Depredation prevention

People undertook a great variety of actions to prevent depredation on their livestock. Methods varied between doing nothing (n = 12), burning areas or scaring with shots in the air or dynamite (n = 12), killing predators for prevention (n = 9), bringing livestock closer to their homes (n = 22), observing their animals more, staying closer and taking better care of them (n = 18), or moving livestock to other locations (n = 17) (Figure 5). Interestingly, there were no significant differences in livestock depredation rate within the six categories (One-way ANOVA: $F_{5, 94} = 1.14$, $P = 0.35$; post hoc Dunnett's t-test all $P > 0.38$). Livestock owners who did nothing to prevent attacks had no higher risks of depredation. Ten interviewees had either not experienced livestock depredation or declined to answer the question.

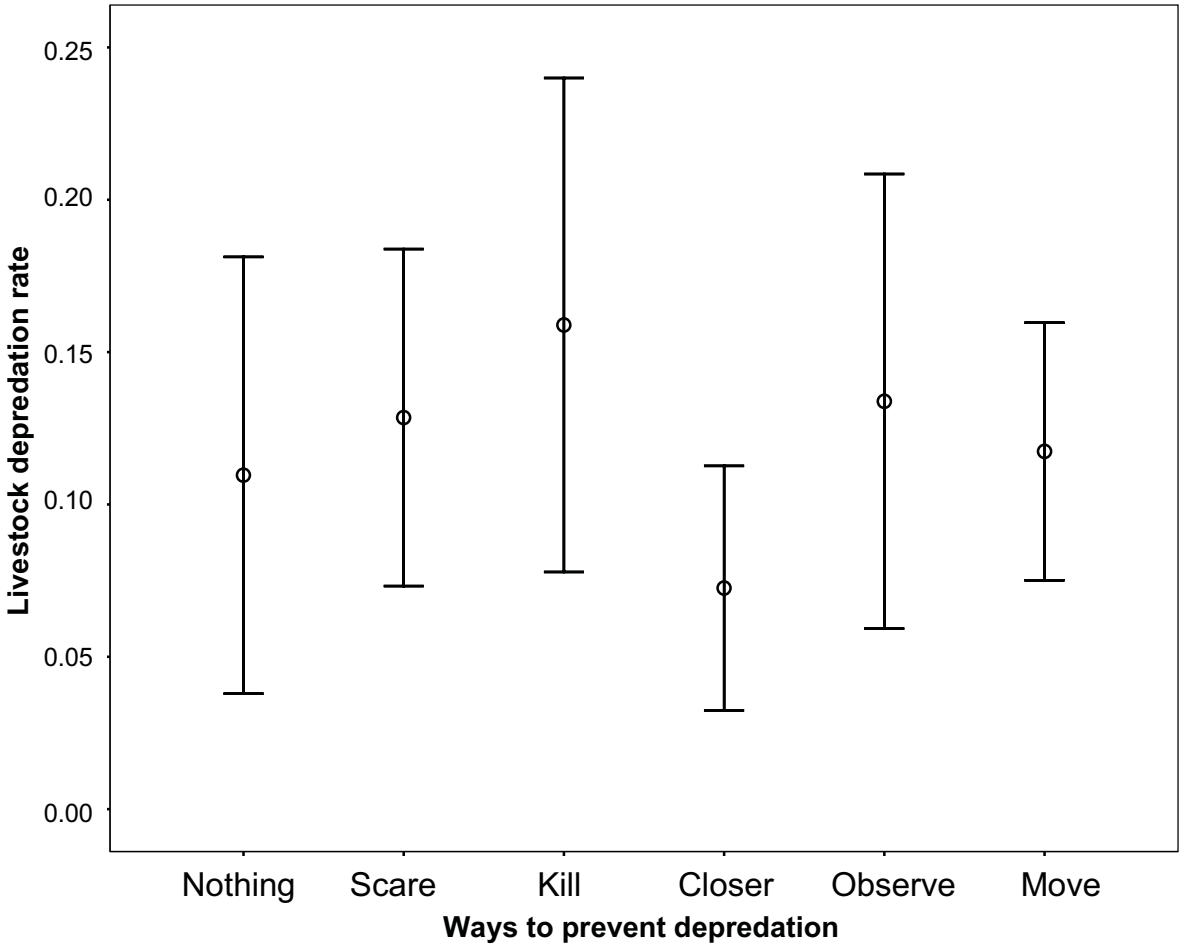


Figure 5. Methods to prevent livestock depredation from spectacled bears, pumas, foxes and condors related to mean livestock depredation rate per household in four areas in the Bolivian Andes from 2005: Nothing) livestock owners who did nothing to prevent attacks, Scare) those who burned areas, shot, or used dynamite to scare the predators away, Kill) killing predators for defence, Closer) bringing the animals closer to the village, Observe) people staying closer and observing the livestock more frequently, Move) those who moved their livestock to other locations. The confidence interval is 95%.

Attitudes and occurrence of hunting

Hunting was widespread; 69% of the interviewed agro-pastoralists reported that predator hunting was common among villagers. Of those, 37% said they hunted or knew others who hunted spectacled bears, 10% reported hunting pumas, 3% condors and 9% foxes. When hunting other animals than predators, 47% hunted viscacha and 27% deer. Only 31% reported that hunting was an illegal act and did not occur. Five respondents voluntarily reported extensive bear hunting, accounting for 20 killed bears since 2000.

Hunting was significantly more widespread in non-protected areas than in protected areas ($\chi^2 = 5.42$, df = 1, P = 0.02). I found negative associations between protected areas and occurrence of bear hunting ($\chi^2 = 11.46$, df = 1, $P < 0.001$), deer hunting ($\chi^2 = 3.99$, df = 1, $P < 0.05$), and hunting of 'other animals' ($\chi^2 = 13.11$, df = 1, $P < 0.001$). There were no difference in hunting of puma, viscacha, fox, and condor in relation to protected areas (all $\chi^2 < 2.26$, all df = 1, all $P > 0.13$).

Of the 69 respondents stating that hunting was normal in the village, 75 % said they hunted for food and materials and 59 % reported hunting to be related to livestock protection (Figure 6A). Two persons reported to have killed a spectacled bear in self defense, or when eating crops. Four persons, mostly from Zongo, hunted to sell or trade in the markets of La Paz (Figure 6B). No one claimed that hunting occurred for cultural reasons.

Figure 6: A) Spectacled bear skin from one of Pelechuco's households. The bear was reportedly killed for livestock protection. B) Paw from spectacled bear for sale at the Witch market in Bolivia's capital La Paz, as a luck-bringing remedy. Photos by Maria C. Knagenhjelm

Whether people lived inside or outside protected areas did not influence their reasons for hunting (all $\chi^2 < 3.05$, all df = 1, all $P > 0.08$). Sex did apparently not influence the level of

hunting activity, though there was a tendency for more hunting among men ($\chi^2 = 2.55$, df = 1, P = 0.11).

Attitudes towards large carnivores and conservation

Among the perceived threats towards the village, 48% identified the spectacled bear as a major threat towards people, 2% reported diseases as a danger to human life and security, and 18% felt that the puma was dangerous. One person reported to have been attacked by puma and five respondents knew of someone attacked by spectacled bears. When asked to explain why and how predators are dangerous, people mostly explained that the bear was dangerous if surprised, while eating or when accompanied by cubs. The puma was stated to attack more often unprovoked and to be more dangerous for children.

A minority of 48% were positive to conservation of large carnivores. However, if I considered respondents only conditionally positive, (i.e. if wild animals did no harm to livestock) the distribution changed to 33% positive and 67% negative. Five respondents did not respond the question.

I found no associations between respondents' livestock depredation rate and their attitudes towards large carnivore conservation (binary logistic regression: B= -1.59, Wald = 0.45, P = 0.5), nor whether people lived in or outside protected areas ($\chi^2 = 0.43$, df = 1, P > 0.5). Age, on the other hand, had a clear influence on peoples attitudes; the younger the person, the more positive (B = -0.40, Wald = 9.26, P < 0.01). Also, people's age influenced the level of fox hunting; the younger the respondent, the more active in hunting fox (B = -0.50, Wald = 4.34, P < 0.04). Nevertheless, I found no significant association between sex and attitude towards conservation, though there was a tendency towards women to be less negative ($\chi^2 = 2.29$, df = 1, P = 0.13). Households with incomes from mining were significantly more positive towards the conservation of large carnivores than those with other sources of income ($\chi^2 = 7.41$, df = 1, P < 0.01). People's hunting activity did not correlate with their view on large carnivore conservation ($\chi^2 = 0.68$, df = 1, P = 0.41), nor was there a relationship between attitudes towards conservation and their involvement in spectacled bear hunting ($\chi^2 = 0.32$, df = 1, P = 0.64). In none of these relationships (predation rate, status of living area, age, sex, source of household income, hunting activity or involvement in spectacled bear hunting) I found any differences between being in favour of large carnivore conservation, and being only *conditionally* in favour of such.

Discussion

Livestock depredation

Between January 2000 and July-August 2006, people in the four study areas in the Bolivian Andes reported loosing on average 2.2 animals per family per year, and 10.3% of their livestock in 2005. Goldstein (1991) concluded that the overall impact of the spectacled bear's predation on livestock in the Venezuelan Andes was negligible. Although that study confirmed the spectacled bear as an active predator on cattle, only 0.02% of the cattle (12 of 140 localities surveyed) were reportedly depredated by bears. In my study the numbers were dramatically higher, suggesting that the study area in La Paz may have different conditions than in the Venezuelan Andes. On the other hand, my results do not differ from similar studies of livestock depredations by wild predators in other high-altitude areas of the world. In the Spiti Region in the Indian Trans-Himalaya, the annual loss of livestock to wild predators in 1995/96 averaged 12% per family, amounting 1.6 livestock/family/year (Mishra 1997), and in 2002/03 an annual loss between 1.1 and 0.6 livestock/family (Bagchi & Mishra 2006). From the Ladakh Region, Indian Trans-Himalaya, each family lost 1.9 livestock or 2.9% per year (Namgail, Fox & Bhatnagar 2007). From Jigme Singye Wangchuck National Park in Bhutan, households lost 2.3% of their livestock holdings to predators during 12 months, or 1.29 livestock head/family (Wang & Macdonald 2006). The livestock loss for the average household in the Bolivian Andes is, according to my study, very serious for their income and quality of life, but is comparable with livestock losses for high-altitude households elsewhere.

My study from the Bolivian Andes has been solely based on interviews, thus verification of numbers is challenging. There should be little incentives for herders or livestock owners to misrepresent loss rates when compensation is not available (Ogada et al. 2003), as is the case for the agro-pastoralist in the Bolivian Andes. On the other hand, people often exaggerate livestock losses to wild predators, either intentionally or because reasons for livestock deaths can be unclear (Oli, Taylor & Rogers 1994), especially if scavenging has occurred. But the agro-pastoralists I interviewed demonstrated a high level of knowledge of wild animals, and they gave numerous and accurate descriptions both of predators and predatory behaviour. Descriptions of the spectacled bear's predatory behaviour have been described similarly from other places (see Goldstein et al. 2006). People's statements on the bear's daily activity was also confirmed from a study in Apolobamba; two male radio-collard bears were active from sunrise (06:00 h) to sunset (20:00-21:00 h), with a rest midday

(Paisley & Garshelis 2006). Concerning statements from respondents about male-biased sex of predatory spectacled bears, studies confirm that within many solitary species, i.e. puma, jaguar, black bear (*Ursus americanus*) and grizzly bear (*Ursus arctos horribilis*), males are more frequently represented than females when individuals are shot or trapped following depredation on livestock (for a review, see Linnell et al. 1999).

Two-thirds of the respondents reported that their livestock also died from other reasons than predation. This mortality was caused by starvation, lack of water, diseases like diarrhoea and fever, parasites, falling down steep hill sides, and eating plastic. One respondent stated that 30 of his cows had recently died of diarrhoea, but this type of data was not collected systematically during this study. Future studies should focus on the total mortality of domestic animals, to compare the extent of depredation versus other causes.

Livestock depredation was higher within protected areas than in non-protected areas between 2000 and 2006, hence indicating a higher level of conflict within borders of protected areas. Increased livestock depredation rates has, in fact, followed establishments of protected areas, both in India (Mishra 1997; Saberwal et al. 1994), and Bhutan (Wang & Macdonald 2006). The time scale of my study is, on the other hand, too short to indicate whether depredation has increased because of establishments of Cotapata NAIM or Apolobamba NAIM. Similar to depredation numbers, livestock numbers per household were significantly higher within protected area's borders. However, most importantly, the depredation *rate* did not differ in relation to the protective status of the area. Still, the fact that the total depredation was higher within protected areas may indicate that these areas accommodate more predators. This is, however, difficult to verify.

Effects of herding practice on depredation

Agro-pastoralists, who left cattle grazing far away from their village or farm, experienced a higher cattle depredation rate than those having cattle closer to people. The same results have been found in the Indian Trans-Himalaya (Mishra 1997). For llama and sheep I found no associations between depredation rate and distance to the village, probably because they seldom were left unattended by people in distant pastures. Like cattle, also horses, mules and donkeys were left unattended far away from the village, but because of few incidents, analysis was not carried out. I have no indications of densities of livestock versus wild prey along the study area, but predation of livestock seems to be particularly widespread where extensive husbandry is practiced (Oli, Taylor & Rogers 1994). Livestock are

intrinsically less evolved to escape predators than wild herbivores, hence they are more vulnerable (Nowell & Jackson 1996). Most large carnivores kill when coming across livestock, indicating the term "problem individual" to include all large carnivores occasionally encountering livestock (Linnell et al. 1999). Because cattle are a vulnerable species left unattended in these predator-dominated areas, protective measures such as joint herding, rotation of pastures near villages, or a ban of grazing in the most frequent predator hotspots may be successful to reduce losses.

Depredation prevention

The respondents conducted a wide range of actions to prevent livestock depredation. However, none of these methods appeared to be effective. More important than people's actual loss in forming their retaliatory action towards the wild predators, is their perceived loss (Mishra 1997). Apparently people with higher livestock depredation rates more often killed predators, and importantly, killing of spectacled bears did not reduce depredation numbers. However, cattle depredation by spectacled bear in the Venezuelan Andes stopped in 23 of 34 events after the "problem individual" had been killed (Goldstein 1991). Goldstein (1991) also reported that predation presumably stopped in the Venezuelan Andes when cattle had been moved to a different area. My results showed a tendency towards a lower mean depredation for agro-pastoralists moving livestock closer after depredation incidents.

Attitudes towards hunting and large carnivore conservation

Hunting spectacled bear, deer and viscacha was widespread within the whole study area. Three of four stated they hunt for food and materials, and more than half hunted for livestock protection. In Pelechuco and Zongo several respondents said they regularly ate bear meat to strengthen their health and to become more intelligent, and I witnessed decorative bear skins in two households in Pelechuco. From the same village a respondent reported that the National Park's director instructed them to kill predators for prevention of livestock depredation. Hunting was significantly more common in non-protected areas, especially for spectacled bears, hence indicating a higher pressure towards bear populations outside protected borders.

Pumas, condors and, to a smaller extent, foxes and spectacled bears, may experience competition from people towards common prey. Reduced availability of wild prey can attract

predators to attack livestock (Woodroffe, Thirgood & Rabinowitz 2005), hence reducing the anthropogenic hunting pressure towards wild prey may reduce peoples livestock loss by offering predators alternative prey. Poaching control should be implemented and education could include a focus on the importance of wild prey availability for predators.

Because my results indicate no correlations between people's livestock depredation rate and their attitudes towards conservation of large carnivores, there must be other factors explaining the majority's negative feelings towards wild carnivores. In southern Brazil, Conforti & de Azevedo (2003) showed that people's perceptions towards large felines were not influenced by their personal experience with livestock depredation. Similarly livestock owners' attitudes towards cheetah (*Acinonyx jubatus*) in Botswana was not negatively affected by personal livestock losses (Selebatso, Moe & Swenson *in press*). Agro-pastoralists with high levels of livestock depredations have been found to be comparatively more tolerant towards carnivores than pastoralists with little or no problems, in India (Bagchi & Mishra 2006), and in Norway (Kaltenborn & Bjerke 2000). In Wisconsin, USA, people's tolerance towards of wolves was more influenced by occupation and social grouping than of their experience with depredation and individual encounters (Naughton-Treves, Grossberg & Treves 2003). Apparently, people's attitudes towards a wild predator is also shaped by their perception of risk (Naughton-Treves 1997; Naughton-Treves, Grossberg & Treves 2003), and of their specific knowledge of a species, i.e. whether a predator needs prey for survival (see Conforti & de Azevedo 2003). Pastoralists' attitudes towards predators improves after raised awareness and knowledge through public educational programmes (Mech 1995; Røskaft et al. 2003). In the Bolivian Andes, age and household incomes from mining were positively associated with people's attitudes. Younger people were more positive than elderly, as also seen in other studies (i.e. Naughton-Treves, Grossberg & Treves 2003; Røskaft et al. 2003), an apparent reason might be that younger people generally are more, and more recently, educated. For people unconditionally in favour of conservation, religion was often an underlying reason, i.e.: 'All animals belong to God's nature'. When supporting conservation, many younger respondents thought a presence of wild carnivores could attract tourists to the area, and hence increase possibilities for employment.

Conclusion

I found a high extent of livestock depredation among agro-pastoralists in the Bolivian Andes, with an increase in depredations by spectacled bear, puma, fox and condor from 2000 to 2006. The spectacled bear is the most problematic predator, accounting for one third of the total livestock depredation. Protected areas accommodate more livestock per household than non-protected areas, but people's depredation rate is similar in and outside protected areas. My results showed an increased depredation rate for cattle grazing far away from the village, and people with the highest mean livestock depredation rate were those who most often killed predators for depredation prevention. Hunting was widespread; spectacled bear hunting was significantly more common outside protected areas, and people mostly hunted for food, materials or livestock protection. I also found a lack of association between depredation rates and people's conservation attitude, whereas lower age and household incomes from mining had positive associations with people's attitudes towards large carnivore conservation. Herding practices might be improved by reducing the extent of unattended grazing, and by having pastures closer to people. Protected-area management could even ban unattended grazing of livestock in distant pastures. Because attitudes towards hunting and carnivore conservation were not influenced by livestock depredation rates, basic education could instead improve people's knowledge about carnivores. And by offering agro-pastoralists alternatives to livestock as a main source of income, dependency on livestock could be reduced, making people less vulnerable when attacks occur. Increasing life quality could also decrease illegal hunting, as the main reason was hunting for food and materials, also including spectacled bear meat. To a certain degree living with carnivores can foster a balanced understanding, and negative attitudes towards carnivore conservation are not necessarily derived from direct interactions, but from a lack of knowledge and tolerance.

References

Bagchi, S. & Mishra, C. (2006). Living with large carnivores: predation on livestock by the snow leopard (*Uncia uncia*). *Journal of Zoology*, 268: 217-224.

Breitenmoser, U. (1998). Large predators in the Alps: The fall and rise of man's competitors. *Biological Conservation*, 83 (3): 279-289.

Cardillo, M., Mace, G. M., Jones, K. E., Bielby, J., Bininda-Emonds, O. R. P., Sechrest, W., Orme, C. D. L. & Purvis, A. (2005). Multiple causes of high extinction risk in large mammal species. *Science*, 309 (5738): 1239-1241.

CIA. (2007). The World Factbook. In *Bolivia*, accessed 11.06.2007 (no. https://www.cia.gov/library/publications/the-world-factbook/print/bl.html) on World Wide Web.

Conforti, V. A. & de Azevedo, F. C. C. (2003). Local perceptions of jaguars (*Pantera onca*) and pumas (*Puma concolor*) in the Iguacu National Park area, south Brazil. *Biological Conservation*, 111: 215-221.

Emmons, L. H. & Feer, F. (1999). *Mamiferos de los bosques humedos de America Tropical: un guia de campo*. Santa Cruz de la Sierra, Bolivia, Fundacion Amigos de la Naturalesa - Noel Kempff. 298 p.

Fernandez, N. (2004). Parque National y Area Natural de Manejo Integrado Cotapata (PN ANMIC), una muestra mas de la riqueza de Bolivia. *El Tunqui*, pp. 2-3.

Fisher, R. J. (1993). Social desirability bias and the validity of indirect questioning. *Journal of Consumer Research*, 20: 303-315.

Fuller, T. K. (1995). An international review of large carnivore conservation status. In Bissonette, J. A. & Krausman, P. R. (eds.) *Integrating people and wildlife for a sustainable future*, pp. 410-412. Bethesda, Maryland, USA, The Wildlife Society.

Goldstein, I. (1991). Spectacled bear predation and feeding behavior on livestock in Venezuela. *Studies on Neotropical Fauna and Environment*, 26 (4): 231-235.

Goldstein, I. (2007). *Spectacled bear conservation in the northern Andes*. In WildlifeConservationUnion (ed.), http://www.wcs.org/international/latinamerica/northernandes/spectacledbears. Accessed 18 May 2007 on World Wide Web.

Goldstein, I., Paisley, S., Wallace, R., Jorgenson, J. P., Cuesta, F. & Castellanos, A. (2006). Andean bear-livestock conflicts: a review. *Ursus*, 17 (1): 8-15.

IUCN. (2006). IUCN Red List of Threatened Species. In *www.iucnredlist.org*, accessed 18 May 2007 on World Wide Web.

Kaltenborn, B. & Bjerke, T. (2000). Hva mener aktørene i rovviltkonflikten? (in Norwegian). *Landbruksøkonomisk Forum*, 3: 19-28.

Kattan, G., Hernandez, O. L., Goldstein, I., Rojas, V., Murillo, O., Gomez, C., Restrepo, H. & Cuesta, F. (2004). Range fragmentation in the spectacled bear (*Tremarctos ornatus*) in the northern Andes. *Oryx*, 38 (2): 155-163.

Kellert, S. R., Black, M., Rush, C. R. & Bath, A. J. (1996). Human culture and large carnivore conservation in North America. *Conservation Biology*, 10 (4): 977-990.

Linnell, J. D. C., Odden, J., Smith, M. E., Aanes, R. & Swenson, J. E. (1999). Large carnivores that kill livestock: do "problem individuals" really exist? *Wildlife Society Bulletin*, 27 (3): 698-705.

Mech, L. D. (1995). The challenge and opportunity of recovering wolf populations. *Conservation Biology*, 9 (2): 270-278.

Michalski, F., Boulhosa, R. L. P., Faria, A. & Peres, C. A. (2006). Human-wildlife conflicts in a fragmented Amazonian forest landscape: determinants of large felid depredation on livestock. *Animal Conservation*, 9: 179-188.

Mishra, C. (1997). Livestock depredation by large carnivores in the Indian Trans-Himalaya: conflict perceptions and conservation prospects. *Environmental Conservation*, 24 (4): 338-343.

Namgail, T., Fox, J. L. & Bhatnagar, Y. V. (2007). Carnivore-caused livestock mortality in Trans-Himalaya. *Environmental Management*, 39 (4): 490-496.

Naughton-Treves, L. (1997). Farming the forest edge: Vulnerable places and people around Kibale National Park, Uganda. *Geographical Review*, 87 (1): 27-46.

Naughton-Treves, L., Grossberg, R. & Treves, A. (2003). Paying for tolerance: rural citizens' attitudes toward wolf depredation and compensation. *Conservation Biology*, 17 (6): 1500-1511.

Navarro, G. & Maldonado, M. (2005). *Geografia ecologica de Bolivia: Vegetacion y ambientes acuaticos*. 3 ed. Santa Cruz, Bolivia. 719 p.

Nowell, K. & Jackson, P. (1996). *Wild Cats. Status survey and conservation action plan*. IUCN/SSC Cat Specialist Group. Gland, Switserland.

Ogada, M., O., Woodroffe, R., Oguge, N. O. & Frank, L. G. (2003). Limiting depredation by african carnivores: the role of livestock husbandry. *Conservation Biology*, 17 (6): 1521-1530.

Oli, M. K., Taylor, I. R. & Rogers, M. E. (1994). Snow Leopard (*Panthera uncia*) predation of livestock - an assessment of local perceptions in the Annapurna conservation area, Nepal. *Biological Conservation*, 68 (1): 63-68.

Paisley, S. (2001). *Andean bears in Apolobamba, Bolivia: culture, conflict and conservation*. Canterbury, University of Kent, Durrell Institute of Conservation and Ecology. 303 p.

Paisley, S. & Garshelis, D. L. (2006). Activity patterns and time budgets of Andean bears (*Tremarctos ornatus*) in the Apolobamba Range of Bolivia. *Journal of Zoology*, 268 (1): 25-34.

ParksWatch. (2004a). Bolivia, Cotapata National Park and IMNA. In *http://www.parkswatch.org/parkprofile.php?l=eng&country=bol&park=conp&page=inf*, accessed 18.06.2007 on World Wide Web.

ParksWatch. (2004b). Bolivia, Apolobamba IMNA. In *http://www.parkswatch.org/parkprofile.php?l=eng&country=bol&park=apna&page=bio*, accessed 18.06.2007 on World Wide Web.

Peyton, B. (1999). Spectacled bear conservation action plan. In Servheen, C., Herrero, S. & Peyton, B. (eds.) *Bears. Status Survey and Conservation Action Plan*. Gland, Switzerland and Camebridge, UK, IUCN/SSC Bear and Polar Bear Specialist Groups.

Rumiz, D. I. & Salazar, J. (1999). Status and management of the spectacled bear in Bolivia. In Servheen, C., Herrero, S. & Peyton, B. (eds.) *Bears. Status Survey and Conservation Action Plan*. Gland, Switzerland and Camebridge, UK, IUCN/SSC Bear and Polar Bear Specialist Groups.

Røskaft, E., Bjerke, T., Kaltenborn, B., Linnell, J. D. C. & Andersen, R. (2003). Patterns of self-reported fear towards large carnivores among the Norwegian public. *Evolution and Human Behavior*, 24 (3): 184-198.

Saberwal, V. K., Gibbs, J. P., Chellam, R. & Johnsingh, A. J. T. (1994). Lion-human conflict in the Gir Forest, India. *Conservation Biology*, 8 (2): 501-507.

Selebatso, M., Moe, S. R. & Swenson, J. E. (*in press*). Farmers support cheetah (*Acinonyx jubatus*) conservation in Botswana despite livestock depredation. *Oryx*.

Servheen, C., Herrero, S. & Peyton, B. (1999). *Bears. Status survey and conservation action plan*. IUCN/SSC Bear and Polar Bear Specialist Groups. Gland, Switzerland and Camebridge, UK.

Treves, A. & Karanth, K. U. (2003). Human-carnivore conflict and perspectives on carnivore management worldwide. *Conservation Biology*, 17 (6): 1491-1499.

Wang, S. R. & Macdonald, D. W. (2006). Livestock predation by carnivores in Jigme Singye Wangchuck National Park, Bhutan. *Biological Conservation*, 129: 558-565.

Woodroffe, R. (2000). Predators and people: using human densities to interpret declines of large carnivores. *Animal Conservation*, 3: 165-173.

Woodroffe, R. (2001). Strategies for carnivore conservation: lessons from contemporary extinctions. In Gittleman, J. L., Wayne, R. K., Macdonald, D. W. & Funk, S. M. (eds.) *Carnivore conservation*, pp. 61-92. Camebridge, UK, Camebridge University Press.

Woodroffe, R. & Ginsberg, J. R. (1998). Edge effects and the extinction of populations inside protected areas. *Science*, 280 (5372): 2126-2128.

Woodroffe, R., Thirgood, S. & Rabinowitz, A. (2005). The future of co-existence: resolving human-wildlife conflicts in a changing world. In Woodroffe, R., Thirgood, S. & Rabinowitz, A. (eds.) vol. Conservation Biology 9 *People and wildlife, conflict or coexistence?*, pp. 338-405. Cambridge, United Kingdom, Cambridge University Press.

APPENDIX 1: Survey of people-predator conflicts in the Bolivian Andes

Survey No. _____

Date_____

Location

1. Protected area_____ (X) Not-protected area_____ (X)

2. Name of PA_____ 3. Name of village _____

4. Name of the farm _____ 5. GPS position of farm _____

Personal Information

6. Sex____ 7. Age____

8. Involvement in occupations, and the importance of these?

(From 1 to 5, where 1 is very important and 5 is of little importance)

	1	**2**	**3**	**4**	**5**
Livestock	□	□	□	□	□
Crops	□	□	□	□	□
Mining	□	□	□	□	□
Commercial Business	□	□	□	□	□
Other_____	□	□	□	□	□

9. If livestock on the farm, how many do you have?

Cattle_____ Llama_____ Sheep_____ Other _____ (Horse, donkey, mule, etc)

10. How do you keep your animals?

	Cattle	**Llama**	**Sheep**	**Other____**
They are kept in a fenced area near the house	□	□	□	□
They are kept in a fenced area outside the village	□	□	□	□
They are herded	□	□	□	□

11. If livestock is held outside the farm/village, how far away are they to go walking?

	Cattle		**Llama**	**Sheep**	**Other____**
Less than one hour	□	□	□	□	
1-3 hours	□	□	□	□	
3-6 hours	□	□	□	□	
More than 6 hours	□	□	□	□	

12. By walking

On a road □ In open landscape □ On a track in the forest □ Deep forest □

13. Does it happen that your livestock die in the open air?

Yes □ No □

14. What are the reasons for the loss of your livestock?

Andean Bear□ Jaguar□ Puma□ Snake□ Condor □ Other_____□

15. Depredation of Cattle_____ Year_____ Month_____ By what?_____

Llama_____ Year_____ Month_____ By what?_____

Sheep_____ Year_____ Month_____ By what?_____

Other _____ Year_____ Month_____ By what?_____

16. If your livestock has been attacked, how do you recognise it done by:
Andean Bear_____
Jaguar_____
Puma_____

17. (If protected area) Have you reported all depredation cases?
Yes□ No□ If NOT; why?_____

18. Have you heard of any other people in your village who have lost livestock?
Yes □ No □ If yes, what livestock_____
by what animal_____

19. What do you do to prevent attacks on your livestock_____
_____

20. Have you seen or heard
Andean Bear □ Jaguar □ Puma □ No □

21. How did it/they look/sound like?_____
_____

22. Do you see any threats to your livestock?
No □ Yes, Andean Bear □ Yes, Jaguar □ Yes, Puma □ Yes, other_____

23. If yes, why?_____

24. Do you see any threats to the people in the village?
No □ Yes, Andean Bear □ Yes, Jaguar □ Yes, Puma □ Yes, other_____

25. If yes, why?_____

26. Is hunting normal in the village?
Yes □ No □ If yes; what animals?_____

27. Why do people hunt?
□ □ □ □ □
Livestock protection Food/Materials Market Cultural purposes Other_____

28. Do you think it is an advantage or a disadvantage to live in a protected area?
Advantage □ Disadvantage □ Why?_____

29. Would you be willing to collaborate in the conservation of large carnivores?
Yes □ No □ Why?_____

30. Other comments_____
_____
_____